

## ***Interactive comment on “Rapid subduction in the deep North Western Mediterranean” by J. A. Aguilar et al.***

**J. A. Aguilar et al.**

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Received and published: 22 June 2010

Reply referee 2 (P. Rhines)

We thank the referee for the comments raised.

Reading through the comments we realized that our writing-up was terse in places. We should have elaborated on the error analysis of vertical current measurement and we should have stressed that our observations are from multiple independent variables, not just vertical current observations. Furthermore, the observations are not “permanent” or “constant with time” but show considerable variability with time, notably a typical 20 days periodicity. All the independent observations merely support each-other. The revised manuscript has been modified accordingly.

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Our detailed replies follow below.

We are not sure what the referee means by “an isolated measurement”. We present yearlong time series from five different parameters (horizontal current component, vertical current component, temperature, acoustic echo back scatter and optics) from multiple instruments. This is not a single measurement, if that is what is meant.

We are not sure what the referee means by “persistent vertical velocity”. Persistent in time or in space and over what scales? We observe time series of vertical motions ( $w$ ) which vary greatly over time, but which can be more or less constant in amplitude for the period of several days. These observations are made near the foot of the (very steep) continental slope in an area which is known for strong meandering (say, mesocale eddy-like) motions which have a typical timescale of 20 days, as observed. We note that not only  $w$ , but all other independent variables (horizontal current, acoustic echo and optics) show such variability with time, albeit with different amplitudes associated with the particular nature of the signals governing each of the different parameters. Tilt is measured by the ADCP, and is fairly constant between 2 and 3 degrees from the vertical. A plot is included in the revised version. The ADCP corrects for tilt internally, but if it were making bias-errors the variation with time in horizontal currents still does not statistically significantly match with the observed vertical currents: sometimes there is correspondence between these components, as can be expected for near-boundary flows, sometimes not. This is best verified in the internal wave band, notably near the inertial frequency. See upper panel of Figure attached. We agree with the concern of the referee on  $w$ -measurements and part of the analysis was vigorous checking of the vertical current and potential errors. One of them is verifying the vertical variation in vertical motions. Although these are quite homogeneous commensurate the near-homogeneity in density distribution, occasional stratification causes a vertical variation, which cannot be inflicted by potential errors due to tilt bias (lower panel Figure attached). This is more elaborated in the revised version now. Our observations do not stand alone. Vertical motions larger than noise level have also



been observed using ADCP in the past in free convection zones (see review by Marshall and Schott, describing observations by e.g. Schott&Leaman, Fisher&Visbeck, see also Lilly et al, 1999), under mesoscale eddies (van Haren et al 2006; Rivas et al. 2008) and as internal waves.

Figure: Approximately one week of time series demonstrating ambiguous relation between vertical motions and horizontal current, and tilt. Upper panel: Current amplitude (blue) and vertical current (multiplied by a factor of 10, red) measured at 30 m below the ADCP. Scale of tilt(light-blue) is to the right; note the small tilt-variations of a few tens of degrees only. In general, variations with time are dominated by inertial period, especially in current magnitude, with which  $W$  is sometimes in-phase, sometimes not. Lower panel: Depth-time series of vertical motions, which show largest amplitudes (most negative values) at about 70 m below the ADCP, in this example.

The “(rather complex) measurement platform” is a quite ordinary mooring line, with the only difference from standard oceanographic mooring lines its electric power and data-transport cable. Naturally, uncommon-oceanographic equipment in the form of optical modules (PMTs in standard oceanographic Benthos glass spheres) are included, but these can be considered as current meters or sediment traps (in terms of elements in a mooring line). The OMs certainly do not introduce the observed vertical motions. This, the ‘storeys’, is better explained now.

The variation in biological parameters at depth is quite unusual. We note that two completely independent types of measurement devices register simultaneous variations in (most likely biologically induced) ocean optics and acoustics.

The observed periodicity of about 20 days is typical for the Northern Current, the boundary current that flows meandering along the Northern-Italian and Southern-French coasts, and thus matches with baroclinic instability in the region. Is it therefore needed to understand the observations. Similarly, the NC borders the coastal region with the open Ligurian Sea and is fed by (deep) dense-water formation in water. As

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a result, convection is imminent in the area. Both processes lead to vertical motions larger than normal. We refute the assertion that the present observations are “isolated”.

ANTARES is a very large project, which can only be established via the contribution of many.

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Interactive comment on Ocean Sci. Discuss., 7, 739, 2010.

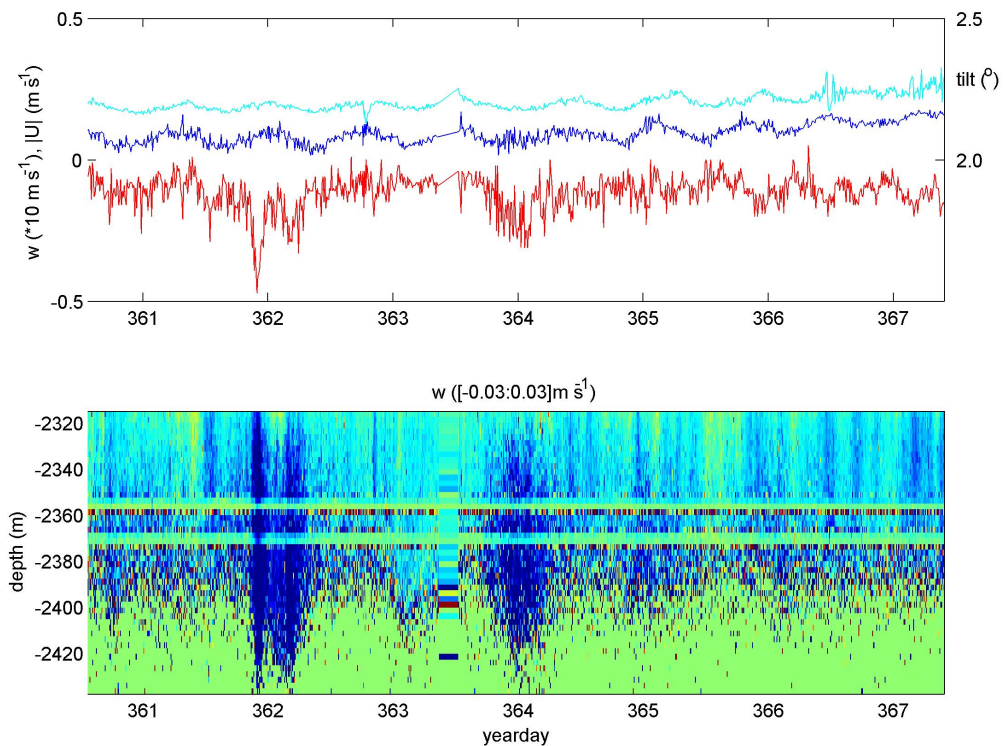
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